REPORT OF THE SIXTH MEETING OF THE ILC PROJECT ADVISORY COMMITTEE (PAC)

19/20 May 2011; Institute of Physics, Academia Sinica, Taipei, Taiwan

Committee: Jean-Eudes Augustin, Paris; Jon Bagger, Johns Hopkins (ILCSC Chair—ex officio); Lyn Evans, CERN (Chair); Akira Masaike, Kyoto; Robert Orr, Toronto; Roy Rubinstein, Fermilab (Secretary); Hans Weise (DESY)

Apologies: Stuart Henderson, Fermilab; Steve Holmes, Fermilab; Katsunobu Oide, KEK; Raj Pillay, TIFR

1. Introduction

The ILC Project Advisory Committee (PAC) was formed in 2008 to assist the International Linear Collider Steering Committee (ILCSC) in the ILCSC's oversight of the ILC accelerator and detector designs. The PAC mandate is given in Appendix I.

The sixth meeting of the PAC took place on 19/20 May 2011 at the Institute of Physics, Academia Sinica, Taipei, Taiwan. The PAC appreciated very much the excellent hospitality of the Institute of Physics which made this meeting possible. The meeting consisted of two days of presentations on the ILC accelerator status and plans and on the status and plans for the ILC detectors. The leadership and the presenters of the ILC accelerator and detector efforts were thanked by the PAC for all of their work which allowed this evaluation of their activities. The meeting agenda is given in Appendix II, and the presentations to the Committee are in Appendix III.

2. Detector Reports

A. Research Director Sakue Yamada first noted a recent change in his Research Directorate, where Francois Richard has been replaced by Juan Fuster as the Regional Contact for Europe.

Yamada said that the environment for obtaining the resources, both people and material, needed by the detector collaborations was becoming more difficult, and it is also becoming more difficult keep up the interest of the community in the ILC. A report on the study of spin-offs from the detector R&D will be completed in Summer 2011.

Yamada noted that the ILD and SiD detectors will both now use the platform method for the push-pull system. The CLIC push-pull design people will join with the ILC push-pull study.

IDAG recommended that both detector groups use a common costing method.

The activities of each of the Common Task Groups were reviewed by Yamada, and he noted that drafts of all sections of an interim report on the detectors are now completed. He also noted the concern of the detector community about what will happen after the DBD is produced in 2012, and the need for further detector R&D and physics studies after that date. Yamada's presentation is in Attachment I.

B. The status of SiD was presented by Norman Graf (Attachment II). He gave the collaboration's work plan up to the 2012 DBD, and the DBD deliverables. SiD is carrying out essential detector R&D, some in collaboration with the "horizontal groups", and there is also collaboration with CLIC. Graf described the current status of the vertex sensor R&D, the digital DHCAL and the KPiX chip for silicon readout; he noted that SiD had agreed to the platform push-pull method. There is ongoing R&D on all subsystems; baseline technologies have been identified and alternates under consideration; major improvements in simulation realism have been made. Graf again noted that manpower and financial resources are limited. In answer to a question, he said that test beam studies of ECAL would begin later in 2011.

C. Yasuhiro Sugimoto gave the status of ILD. He said that the collaboration relies heavily on the "horizontal" R&D groups such as CALICE, and it is still waiting for official 1 TeV parameters from the GDE. The Japan earthquake has impacted some ILD activities. Studies are underway on power pulsing, where the detector electronics are only powered during the beam bunch train, in order to reduce power consumption. Sugimoto said that for the DBD there will be one option or alternate for each detector subsystem, and the collaboration will not down-select on subdetector technology for the DBD; the hardware baseline will include several options. Sugimoto said that a site dependent design for ILD has started, and he mentioned the problems caused by lack of resources. Sugimoto's presentation is in Attachment III.

In answer to questions, Sugimoto said that ILD wants to continue the study of the alternate technologies; because of this, a range of costs will be given in the DBD.

3. **Accelerator Reports**

A draft technical progress report was given to the Committee, and is available as Attachment IV

A. Barry Barish gave the GDE project status (Attachment V). He said that the accelerator baseline for the TDR has now been established, following the final 2 baseline changes recently approved. The baseline has a single tunnel; 31.5 MV/m gradient; reduced parameter set; and positron source at the end of the electron linac. On cavities, the baseline gradient for vertical test acceptance is 35 MV/m, with an allowed +-20% spread; for operation, it is 31.5 MV/m with an allowed +-20% spread. Barish noted that SCRF R&D work will continue past 2012, and again pressed for global coherence of the GDE work after 2012.

Barish said that the TDR, which is on track for completion by the end of 2012, will quote costs in 2012 US$; in making comparisons with the RDR, account needs to be taken of the differences in exchange rates since 2007 and also that escalation since 2007 is country-dependent. Using 2012 US$, it is expected that the RDR design will cost ~15% more, partially offset by an expected -10% due to the baseline changes. A draft of the Project Implementation Plan (PIP) should be available by mid-summer 2011.

For cost effective cavity and cryomodule production, Barish said that the ILC lab should be responsible for performance, while industry will build to print. He reiterated that the GDE-like global decision-making and coordination must be kept in any new pre-project organization that is put in place after 2012. He said that planning for the post-2012 era is very important, and the work should include a cost-effective 1 TeV design.

In answer to a question, Barish said that he guessed that value engineering might lead to a 10-20% cost reduction.

B. A report on SCRF cavity progress since the previous PAC meeting was given by Rongli Geng (Attachment VI). He said that in the Americas mechanical polishing at Fermilab has raised a cavity's gradient from 19 to 35 MV/m; JLab is has achieved over 80% yield at 35 MV/m, and is testing a DESY 9-cell seamless cavity. In Asia, a KEK cavity has reached 40.7 MV/m, and a KEK/JLab Ichiro cavity has achieved 40 MV/m; some individual cells have reached 50 MV/m. 45 MV/m has been reached in Europe.

Geng said that for 1 TeV, gradients of 40-45 MV/m, or higher, would be desirable, with a yield at 45 MV/m of 90%, and a Q0 of 1-2 E10 at 40 MV/m.

C. Hitoshi Hayano reported on the S1 Global test of cavity integration at KEK (Attachment VII). The collaboration was international, with cavities, input couplers, tuners, etc. from different labs. Among the tests was removal of the Circulator (for possible cost reduction), a study of whether the 5 K shield is necessary (for cost reduction), and a study of DRFS for RF power distribution. Hayano gave some of the main conclusions of the test: the average gradient produced was 26 MV/m; Circulator removal worked; 5 K shield removal worked; the DESY PXFEL cryomodule was well above XFEL specifications. He then listed issues which the test showed need to be addressed: there is cavity performance degradation in the cryomodule; there is X-ray emission in the cryomodule; there is low cavity Q0 in the cryomodule; there were a couple of vacuum trips; and there were tuner failures.

D. Planning for cavity industrialization was discussed by Akira Yamamoto. Vendors were visited in 2009, and a workshop organized in 2010. Later in 2011, a report will be received following the sending of specifications to manufacturers. There will be visits and communication with potential vendors, and study of a possible factory layout (KEK), system engineering for mass production (CERN) and a study of mass production technology (Fermilab).

A request for information from companies will ask for cost comparisons of 20/50/100% of total required cavities, in 3 or 6 year production; company or lab site location? responsibilities shared for cost effectiveness? deliverables with "build to print" fabrication; consortium or not?

Yamamoto said that so far most replies want ~ 20% of the total cavities. He described a cavity factory layout under consideration at KEK, and plans for further communication with industry in 2011. Yamamoto's presentation is in Attachment VIII.

In discussions after Yamamoto's presentation, it was commented that a pilot plant at KEK will be very valuable in allowing the manufacturing procedures to be verified, and "never ask a company to do something you can't do yourself".

E. The R&D program at FLASH was reviewed by Marc Ross (Attachment IX). He showed the program goals, and what has been achieved up to the present, including highest gradient operation, Lorentz force detuning, and cavity gradients over the 400 microsecond pulse flat-top. Next steps are operation within a few % of quench with ILC like gradients, and flattened gradients with 6ma 800 microsecond pulses. Ross said that ILC studies should end with a run in January 2012.

Comments following Ross' presentation agreed that the results so far are very impressive.

F. Toshiaki Tauchi discussed the ATF2 program, both up the March earthquake, the effects of the earthquake, and the future schedule (Attachment X). He said that ATF2 is now expected to resume operations in October 2011. He noted that up to now running past April 2013 is not funded, and any operation beyond then is under discussion. A sigma-y* at the IP of 280+-90 nm has been achieved, with beta*x of 10 mm and beta*y of 0.1 mm. A major priority is to achieve an IP sigma-y* of 37 nm.

G. Mark Palmer (Attachment XI) described the CesrTA program, and said that a report on Phase 1 operations is in preparation. Phase 2 funding for 3 years has just been received, and he showed the modifications that will be done to CESR for this work. Palmer described electron cloud mitigation procedures validated by the studies for each of quadrupoles, dipoles and wigglers, and said that he believed that a 3.2 KM Damping Ring (DR) can achieve the low-power option goals. There is still some concern regarding the high power option, but a second positron DR is always a backup option.

4. **Reports on Common Detector/Accelerator Issues**

A. Costing

(i) Accelerator

Peter Garbincius reviewed the costing of the RDR accelerator, which totaled 6.6B ICU units and 24M hours of institutional labor; ILC units were 2007 US$. With 6% inflation and 9% exchange rate change since then, this would now be 7.6B ICU units. For the TDR, there will be escalation and some new costs; as an example of changes, he said that the SB2009 proposals would reduce costs by 10.7%. Garbincius gave dates for producing the TDR cost estimate. He noted that estimates are not yet available for a shallow site. His presentation is in Attachment XII.

(ii) Detectors

Sakue Yamada gave the current status of costing for the detectors (Attachment XIII). IDAG recommended that ILD and SiD use the same costing methodology. They should assume the same funding mechanisms as for past large detectors: the detectors will be built by large international teams, each with many participating members, institutions and countries; and contributions will be in-kind with some common funds.

Yamada said that a costing subgroup from the experiments has been set up, with Peter Garbincius as an advisor. Material and manpower costs will be listed separately, and the reference currency will be 2012 US$. The same price will be used by both detectors for such items as Si, W, Fe, and stainless steel, although Yamada noted the uncertainty in future prices. Treatment of contingency, exchange rate fluctuations, and converting manpower to currency, are all under discussion.

B. New Baseline

(i) Accelerator

Nick Walker (Attachment XIV) reviewed the SB2009 process; the single tunnel, accelerator operating gradient, low power parameters, and positron source location have been approved, although with comments on each of them from the change control process. The average gradients will be greater that 31.5 MV/m with Q0 greater that 1E10; with +-20% gradient spread, an additional 10-15% RF power capacity is needed. With a single tunnel, DRFS or KCS power distribution systems are assumed (depending on site characteristics), with the RDR system as a backup. Reducing the number of bunches from 2600 to 1300 allows a x2 reduction in DR size to 3.2 Km circumference; however, stronger IR focusing is required to gain back the lost luminosity. The positron source move allows consolidation of the central area.

Walker described work still to be done, including the single stage bunch compressor and the central region integration; study of the upgrade to 1 TeV is getting underway.

(ii) Detectors

The major effect of the SB2009 proposals, reported Jim Brau (Attachment XV), was the physics performance degradation, especially the reduced luminosity at low energies. The proposals were subsequently revised by GDE, and Brau said that the low energy impact was largely ameliorated. He noted that polarization of both beams compensated in some reactions for reduced luminosity, and said that the physics reach was enhanced with positron polarization. Brau reiterated that running at the HZ threshold is very important.

C Machine-Detector Interface

Toshiaki Tauchi reviewed the ongoing work of the MDI Common Task Group (Attachment XVI). He said that the platform push-pull system has been adopted by both ILD and SiD, and he

showed a revised experimental hall layout. Studies have been made of the tolerance of luminosity loss against QD0 jitter. Collaboration with CLIC will increase.

C. ILC-CLIC Collaboration

(i) Detectors

The two detectors in the CLIC design are CLIC_ILD and CLIC_SiD, both of which are modifications of the ILC designs in which the tracking and EM calorimeter are unchanged, reported Juan Fuster (Attachment XVII). He commented that detector R&D covers many regions, funding sources, and oversight bodies---a complex situation but it seems to work. Fuster concluded that the ILC-CLIC collaboration on detectors is working, and both communities are committed to cooperation. He listed the many cooperative tasks, and the joint organization of linear collider workshops; the major worry is lack of adequate resources.

(ii) Accelerator

Mike Harrison noted that CLIC-ILC collaboration is now in the CERN 5-year plan. He discussed activities of each of the 6 technical groups and also the General Issues Working Group. The latter presented a report to ILCSC and the CLIC Collaboration Board earlier in 2011. Among items under study are whether there are specific CLIC site requirements; the need to determine the systems tests needed for both projects; and a recommendation for both projects to present a cost estimate for a 1 TeV case. Harrison said that future topics for the General Issues Working Group were under discussion.

Harrison commented that the ILC-CLIC collaboration was working at the grass roots level; the General Issues Working Group seems to have a legitimate role, and 2012 will provide a coincidence between the EU strategy report, the CLIC CDR, and the GDE TDR. He said that there is obvious interest in developing linear collider collaboration in the future. Harrison's presentation is in Attachment XVIII.

5. PAC Summary and Recommendations

A. General

1. As at the previous PAC meeting, the PAC again recommends the need for ILCSC and ICFA to work towards a post-2012 strategy for ILC activities, so that the accelerator and detector teams can efficiently continue their work after completion of the TDR and DBD documents

B. Accelerator

1. The PAC believes that a primary current responsibility of the GDE is to keep costs under control through the TDR phase
2. The Committee strongly favors the cryomodule production model where industry builds to print and HEP lab(s) take responsibility for meeting performance specifications
3. The PAC is very encouraged by the progress that has been achieved so far towards reaching the cavity gradient goals
4. The problems which arose during the recent first S1 Global test are a cause for concern, and the Committee supports a careful disassembly of the equipment followed by a report on the findings
5. The progress made in the studies at the FLASH, CesrTA, and ATF2 test facilities is impressive, and the Committee strongly supports continuation of this work
6. The PAC strongly supports the KEK pilot plant project for cavity production

C. Detectors

1. The PAC again notes the lack of resources, both financial and human, for ILC detector activities, with the consequent loss of young people to other projects
2. The Committee notes that the ILC detector R&D work has applications to other particle physics projects, and again encourages the publication of the spin-offs from this work
3. The PAC has concerns about the apparent many options currently under consideration in the ILD design, and believes that there is need for some reduction in the number of these options prior to completion of the DBD
4. The Committee notes that studies have demonstrated the increased physics reach enabled by positron beam polarization
5. The PAC understands that detector computing costs will be provided in the DBD

6. **Next PAC Meeting**

The next PAC meeting will be take place at the Institute of Physics, Academy of Sciences of the Czech Republic, Prague on 14/15 November 2011.

Appendix I

ILC Project Advisory Committee (PAC) Mandate

1. The International Linear Collider Steering Committee (ILCSC) is responsible for the oversight of the Global Design Effort (GDE) activities and of the ILC experimental program.

2. PAC will assist ILCSC in this function and report to the ILCSC.

3. PAC will review the GDE accelerator activities and, in addition, the ILC detector activities.

4. In its review activity, PAC will examine the overall consistency and realism of the project, in relation to physics, technical design, cost, and schedule.

5. PAC shall comprise about nine members, appointed by the ILCSC for terms of two or three years, and will meet a few times per year until the completion of the Technical Design Phases I and II.

6. The PAC Chair will be appointed by the ILCSC, normally for a two-year term.

Appendix II

PAC Review

Academia Sinica, Taipei, Taiwan
19/20 May 2011

Thursday 19 May

08:30	Executive Session			
09:00	Research Director's Report		(45+15)	S. Yamada
10:00	SiD		(30+10)	N. Graf
10:40	Break		(20)	
11:00	ILD		(30+10)	Y. Sugimoto
11:40	Executive Session			
12:30	Lunch			
13:30	GDE Director's Report		(45+15)	B. Barish
14:30	SCRF R&D		(45+15)	R. Geng, H. Hayano
15:30	Break		(15)	
15:45	Cavity Industrialization Planning		(30+10)	A. Yamamoto
16:25	Costing	a) Accelerator	(20+10)	P. Garbincius
		b) Detectors	(20+10)	S. Yamada
17:25	Executive Session			
18:55	Dinner			

Friday 20 May

08:30	R&D Programs at FLASH, ATF		(30+10)	M. Ross, T. Tauchi
09:10	Final Review of CesrTA R&D Program		(20+10)	M. Palmer
09:40	New Baseline	a) Accelerator	(20+10)	N. Walker
		b) Detectors	(20+10)	J. Brau
10:40	Break		(15)	
10:55	MDI		(35+10)	T. Tauchi
11:40	Collaboration with CLIC	a) Detectors	(20+10)	J. Fuster
		b) Accelerator	(20+10)	M. Harrison
12:40	Lunch			
13:40	Executive Session			
14:40	Closeout			
15:25	End			

Appendix III

The Attachments, including the presentations made to the PAC, are available at
http://www.fnal.gov/directorate/ILCPAC/May2011/Attachments.html